CLAIMS

What is claimed is:

1. An electrolyte for a lithium-sulfur battery having a positive and negative electrode, comprising:

a first solvent having a dielectric constant that is greater than or equal to 20;

a second solvent having a viscosity that is less than or equal to 1.3; and

an electrolyte salt.

2. The electrolyte for the lithium-sulfur battery of claim 1, wherein said first solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate, dimethyl sulfoxide, sulforane, γ-butyrolactone, acetonitrile, dimethyl formamide, methanol, hexamethyl phosphoramide, ethanol, and isopropanol.

3. The electrolyte for the lithium-sulfur battery of claim 1, wherein said second solvent is at least one selected from a group consisting of methylethyl ketone, pyridine, methyl formate, tetrahydrofurane, diglyme (2-methoxyethyl ether), 1,3-dioxolane, methyl acetate, 2-methyl tetrahydrofurane, ethyl acetate, n-propyl acetate, ethyl propionate, methyl propionate, ethyl ether, diethyl carbonate, methylethyl carbonate, dimethyl carbonate, toluene, fluorotoluene, 1,2-dimethoxy ethane, benzene, fluorobenzene, p-dioxane, and cyclohexane.

4. The electrolyte for the lithium-sulfur battery of claim 1, wherein:

said first solvent is roughly between 20% and 80 % by volume of the electrolyte, and

said second solvent is roughly between 20% and about 80 % by volume of the electrolyte.

5. The electrolyte for the lithium-sulfur battery of claim 1, further comprising an additive that forms a solid electrolyte interface (SEI) at a surface of the negative electrode during charging.

6. The electrolyte for the lithium-sulfur battery of claim 5, wherein said additive is at least one selected from a group consisting of vinylene carbonate, vinylene trithiocarbonate, ethylene trithiocarbonate, ethylene sulfite, ethylene sulfide and bismuth carbonate.

7. The electrolyte for the lithium-sulfur battery of claim 5, wherein said additive is roughly between 0.2% and 10 % by weight of the electrolyte.

8. The electrolyte for the lithium-sulfur battery of claim 1, wherein said electrolyte salt is at least one selected from a group consisting of lithium hexafluorophosphate ($LiPF_6$), lithium tetrafluoroborate ($LiBF_4$), lithium hexafluoroarsenate ($LiAsF_6$), lithium perchlorate ($LiClO_4$), lithium trifluoromethane sulfonyl imide ($LiN(CF_3SO_2)_2$), and lithium trifluorosulfonate (CF_3SO_3Li).

9. The electrolyte for the lithium-sulfur battery of claim 1, wherein a concentration of said electrolyte salt is roughly between 0.5 M and 2.0 M.

10. A lithium-sulfur battery comprising:

a negative electrode comprising a negative active material selected from a group consisting of lithium metal, lithium-containing alloy, a combination electrode of a lithium/inactive sulfur, a compound that can reversibly intercalate lithium ion, and a compound that can reversibly redoxidate with a lithium ion at a surface;

an electrolyte comprising a solvent having a dielectric constant that is greater than or equal to 20, a solvent having a viscosity that is less than or equal to 1.3, and an electrolyte salt; and

a positive electrode comprising a positive active material comprising at least one sulfur-based material selected from a group consisting of a sulfur element, Li_2S_n ($n \geq 1$), an organic sulfur compound, and a carbon-sulfur polymer ($(C_2S_x)_n$ where $x=2.5$ to 50 and $n \geq 2$), and an electrically conductive material.

11. An electrolyte for a lithium-sulfur battery, comprising:

a first solvent having a polarity high enough to dissolve an ionic compound;

a second solvent having a viscosity that is less than or equal to 1.3; and

an electrolyte salt.

12. A lithium-sulfur battery comprising:

a negative electrode comprising a negative active material;

an electrolyte comprising

a first solvent having a polarity high enough to dissolve an ionic compound,

a second solvent having a viscosity that is less than or equal to 1.3, and

an electrolyte salt; and

a positive electrode comprising a positive active material.

13. The lithium-sulfur battery of claim 12, wherein the first solvent has a dielectric constant that is greater than or equal to 20.

14. The lithium-sulfur battery of claim 12, wherein the first solvent is at least one selected from a group consisting of ethylene carbonate, propylene carbonate, dimethyl

sulfoxide, sulforane, γ-butyrolactone, acetonitrile, dimethyl formamide, methanol, hexamethyl phosphoramide, ethanol, and isopropanol.

15. The lithium-sulfur battery of claim 12, wherein the second solvent is at least one selected from a group consisting of methylethyl ketone, pyridine, methyl formate, tetrahydrofurane, diglyme (2-methoxyethyl ether), 1,3-dioxolane, methyl acetate, 2-methyl tetrahydrofurane, ethyl acetate, n-propyl acetate, ethyl propionate, methyl propionate, ethyl ether, diethyl carbonate, methylethyl carbonate, dimethyl carbonate, toluene, fluorotoluene, 1,2-dimethoxy ethane, benzene, fluorobenzene, p-dioxane, and cyclohexane.

16. The lithium-sulfur battery of claim 12, wherein:

the first solvent is roughly between 20% and 80 % by volume of said electrolyte, and

the second solvent is roughly between 20% and about 80 % by volume of said electrolyte.

17. The lithium-sulfur battery of claim 12, wherein a ratio of the first solvent to the second solvent is roughly 1:1.

18. The lithium-sulfur battery of claim 12, wherein said electrolyte further comprises an additive that prevents the formation of dendrite on a surface of said negative electrode during charging.

19. The lithium-sulfur battery of claim 18, wherein the additive forms a solid electrolyte interface (SEI) at the surface of said negative electrode.

20. The lithium-sulfur battery of claim 18, wherein the additive is at least one selected from a group consisting of vinylene carbonate, vinylene trithiocarbonate, ethylene trithiocarbonate, ethylene sulfite, ethylene sulfide and bismuth carbonate.

21. The lithium-sulfur battery of claim 18, wherein the additive is roughly between 0.2% and 10% by weight of said electrolyte.